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# Superconducting Magnet R&D

## Cost Estimate

S. Gourlay, LBNL

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## Cost Estimate Considerations

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- New Technological Territory
  - How difficult will it be?
  - What form will upgrade take?
  - What are technological limits?
- Cost model illustrates scope of R&D program that is possible with available funding – NOT a detailed plan
- Simultaneously, develop technology and define application

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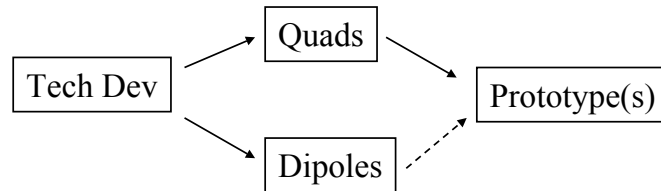
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## Basic Program

Start with model based on what we know now

- Combine
  - Technology Development
  - Quadrupoles
  - Dipoles
- Divisions arbitrary
- More for quads
  - Primary focus
  - Include 4m models



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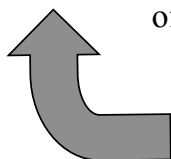
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## Magnet Program Profile

		FY04	FY05	FY06	FY07	FY08	FY09	FY10
Subscale Tests		1	3	6	5	4	3	2
Simplified 1m Q				1	1			
1m Q					1	2	2	2
1m D					1	1	1	1
4m D or Q models							0.25	1

24 Sub-Scale tests  
2 Simplified models  
7 Quad models  
4 Dipole models  
1 4 m model



Solid technology development base  
complemented by a series of models  
of varying complexity

Slow start is a problem  
Can Base Programs help?

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## Cost Estimate Basis

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- Start with costs from . . .
  - LHC Quad Program
  - High Field magnet programs at the labs
- Apply to . . .
  - 4-layer, large aperture quad (Dipole same as quad)
- Scale for . . .
  - Material
  - Length

Relative cost scale Costs of design and tooling amortized
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	FTE	Labor	M&S	Total
Technology Development	0.75	124	44	168
Simplified Models	4.5	804	377	1181
1 m Dipole/Quad	8	1211	855	2066

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## M&S Cost Detail

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<u>Parts</u>	<u>1 m</u>	<u>4 m</u>
Cable	\$163k	\$650k
Coil Assembly	\$180k	\$525k
Cold Mass	\$56k	\$134k
Test	\$46k	\$46k
Total	\$444k	\$1355k
<u>Tooling</u>		
Coil	\$733k	\$2240k
Cold Mass	\$188k	
Total	\$921k	\$2240k

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## Magnet R&D Cost Overview

	FY04	FY05	FY06	FY07	FY08	FY09
<b>LABOR COUNT</b>	1.6	5.5	21.0	20.0	20.6	20.7
<b>LABOR COST</b>	288	940	3168	3064	3152	3148
<b>TRAVEL</b>	6	18	41	42	43	42
<b>MATERIAL &amp; SERVICES</b>	20	358	2920	2091	3010	3021
<b>TOTAL COSTS</b>	<b>314</b>	<b>1315</b>	<b>6128</b>	<b>5196</b>	<b>6205</b>	<b>6210</b>
<b>Escalated</b>	<b>323</b>	<b>1395</b>	<b>6697</b>	<b>5849</b>	<b>7193</b>	<b>7415</b>
Guideline	325	1400	6695	5845	7185	7425

Travel budget allows \$5k/yr per scientist and engineer

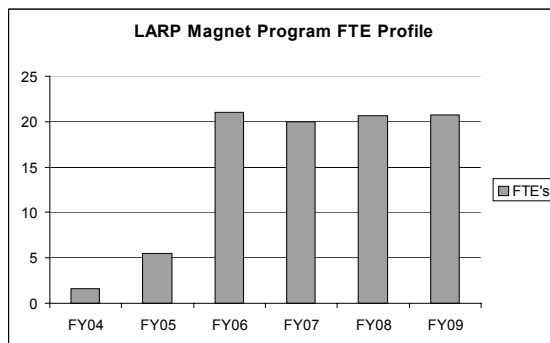
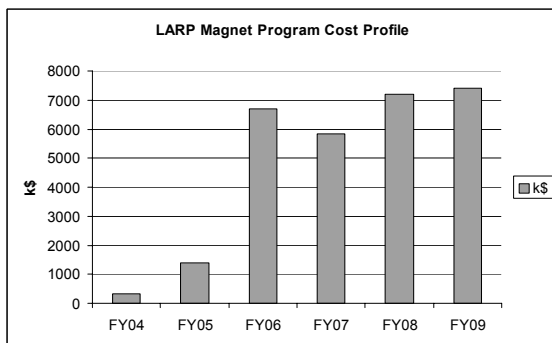
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## Cost and FTE Profiles



Program profiles based on budget guidance

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## Enhanced Magnet R&D Program

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- Greater assurance of success of the R&D for high-performance magnets for luminosity upgrade
    - More vigorous start
    - Robust program – risk mitigation
    - Ensures R&D on both dipoles and quads
  - Compare to Program based on budget guidelines
    - Additional sub-scale tests early in program
    - Healthier technology development component to support main program
    - 1 additional simplified model
    - 5 models/yr compared to 3/yr
    - Earlier start of 4m program
    - Commensurate increase in management and budget
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## Enhanced Magnet R&D Program

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		FY04	FY05	FY06	FY07	FY08	FY09	FY10
Subscale Tests		1	3	6	5	4	3	2
Simplified 1m Q				1	1			
1m Q					1	2	2	2
1m D					1	1	1	1
4m D or Q models							0.25	1

		FY04	FY05	FY06	FY07	FY08	FY09	FY10
Subscale Tests		2	4	6	6	5	4	3
Simplified 1m Q				1	2			
1m Q					1	3	3	3
1m D					2	2	2	2
4m D or Q models						0.25	1	2

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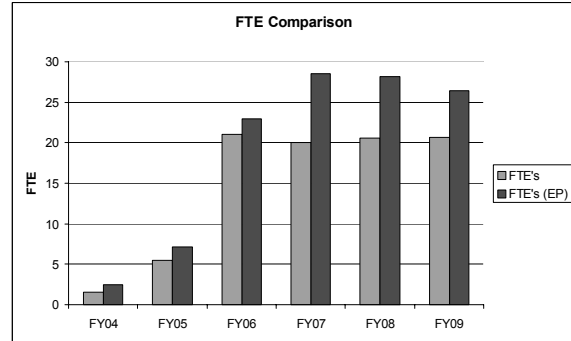
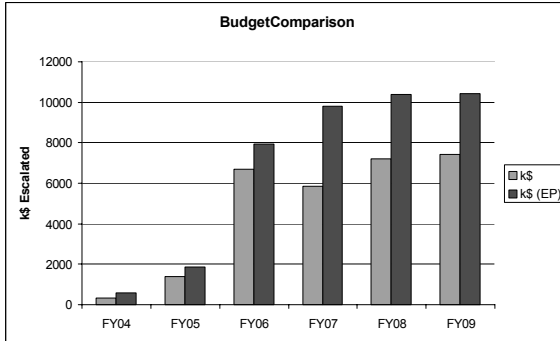
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## Base and Enhanced Program Comparison

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## Summary

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- Significant program of Nb<sub>3</sub>Sn magnet development
  - Makes extensive use of existing programs and infrastructure
    - Cost efficient
- Need an early start to assess scope and refine the program
- Baseline program is committed to complete development of at least one magnet type
  - A modestly enhanced program will . . .
    - Mitigate technical risk
    - Add assurance that we can successfully develop two types of magnet

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